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(54) **VEHICLE SEAT ASSEMBLY HAVING A
HARDNESS GRADIENT VIA "A" SURFACE
INTRUSIONS AND/OR PROTRUSIONS**

(71) Applicant: **Lear Corporation**, Southfield, MI (US)

(72) Inventors: **Asad S. Ali**, Troy, MI (US); **Ashford A.
Galbreath**, Troy, MI (US)

(73) Assignee: **LEAR CORPORATION**, Southfield,
MI (US)

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(56) **References Cited**

U.S. PATENT DOCUMENTS

3,331,089 A 7/1967 Ornas, Jr. et al.
3,869,831 A 3/1975 Gibb
4,522,447 A 6/1985 Snyder et al.
4,696,516 A 9/1987 Yeum

(Continued)

FOREIGN PATENT DOCUMENTS

CA 1139024 A1 1/1983
DE 298 05 926 U1 7/1999

(Continued)

OTHER PUBLICATIONS

U.S. Appl. No. 60/555,195 to San Migueuel (Priority Application to
WO 2006/102751) 54 Pages.

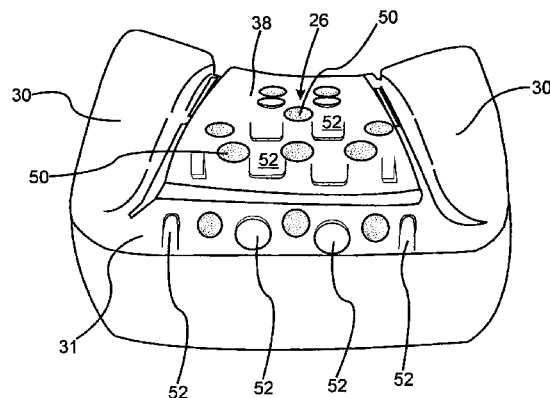
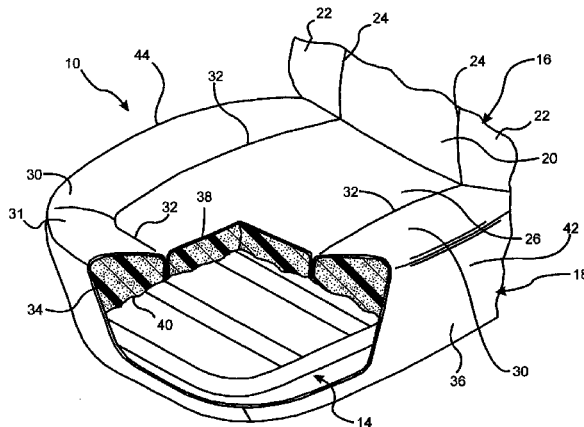
Primary Examiner — Ryan J Walters

(74) *Attorney, Agent, or Firm* — Brooks Kushman P.C.

(57) **ABSTRACT**

In at least one embodiment, the present invention provides a
vehicle seat assembly comprising a cushion having an "A"
surface and a "B" surface, a central portion, and two bolster
areas, with each bolster area being adjacent the central por-
tion, with the cushion having a plurality of intrusions extend-
ing from the "A" surface towards the "B" surface to form a
hardness gradient between at least one of the bolster areas and
the central portion of between 8% to 25%.

20 Claims, 4 Drawing Sheets



(56)

References Cited

U.S. PATENT DOCUMENTS

4,755,411 A 7/1988 Wing et al.
 5,000,515 A 3/1991 Devieu
 5,085,487 A 2/1992 Weingartner et al.
 5,226,188 A 7/1993 Liou
 5,294,181 A 3/1994 Rose et al.
 5,343,876 A 9/1994 Rogers
 5,442,823 A 8/1995 Siekman et al.
 5,492,662 A 2/1996 Kargol et al.
 5,544,942 A 8/1996 Vu Khac et al.
 5,564,144 A 10/1996 Weingartner et al.
 5,617,595 A 4/1997 Landi et al.
 5,816,661 A 10/1998 Sakurai et al.
 5,872,714 A 2/1999 Shaikh et al.
 5,944,389 A 8/1999 Zenba et al.
 6,063,461 A 5/2000 Hoyle et al.
 6,082,824 A 7/2000 Chow
 6,144,890 A 11/2000 Rothkop
 6,293,625 B1 9/2001 Dixon
 6,546,578 B1 4/2003 Steinmeier
 6,588,086 B2 7/2003 Trybus
 6,701,556 B2 3/2004 Romano et al.
 6,899,399 B2 5/2005 Ali et al.
 6,941,188 B1 9/2005 Arnold, II

7,334,278 B2 2/2008 Yamasaki
 7,533,941 B2 5/2009 Saitou et al.
 7,588,296 B2 9/2009 Ebe
 7,661,764 B2 2/2010 Ali et al.
 9,038,252 B2 5/2015 Ali et al.
 2004/0262963 A1 12/2004 Ali et al.
 2007/0112086 A1 5/2007 Matsumoto et al.
 2007/0236072 A1 10/2007 Galbreath et al.

FOREIGN PATENT DOCUMENTS

DE 297 24 346 U1 12/2000
 DE 10038830 A1 12/2001
 DE 10030708 A 1/2002
 DE 20202042 U 6/2002
 EP 0 021 191 A3 6/1980
 EP 1679327 A1 7/2006
 GB 2 063 065 A 6/1981
 JP 9076797 A 3/1997
 JP 10117891 A 5/1998
 JP 2000189272 A 7/2000
 JP 2002112856 A 4/2002
 WO 2005040243 A1 5/2005
 WO 2005122834 A1 12/2005
 WO 2006102751 A1 10/2006
 WO 2007053035 A2 5/2007

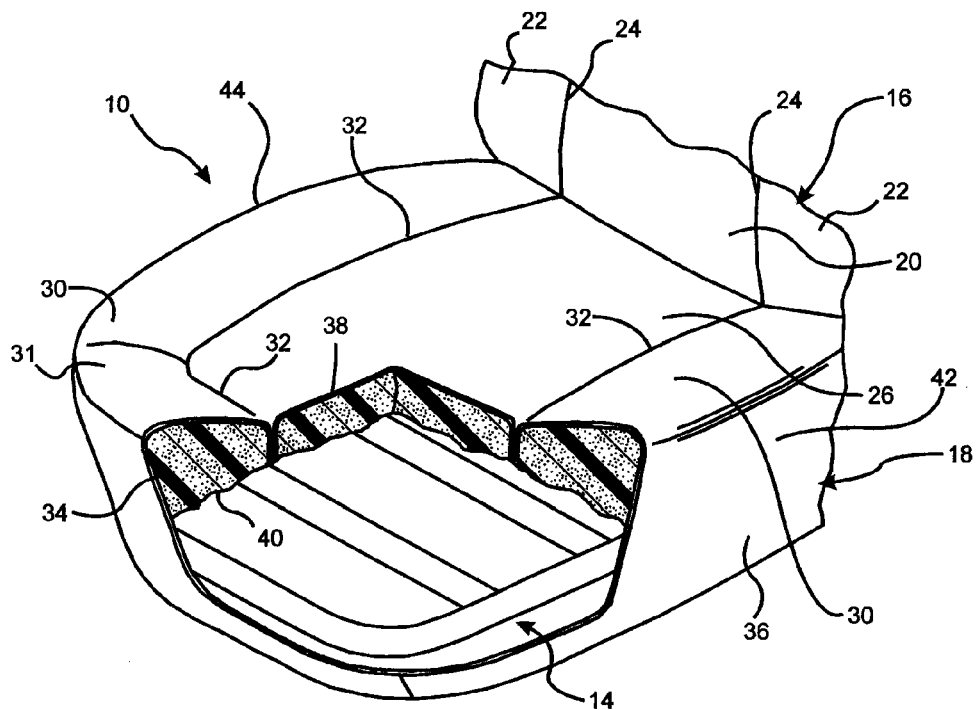


Figure 1

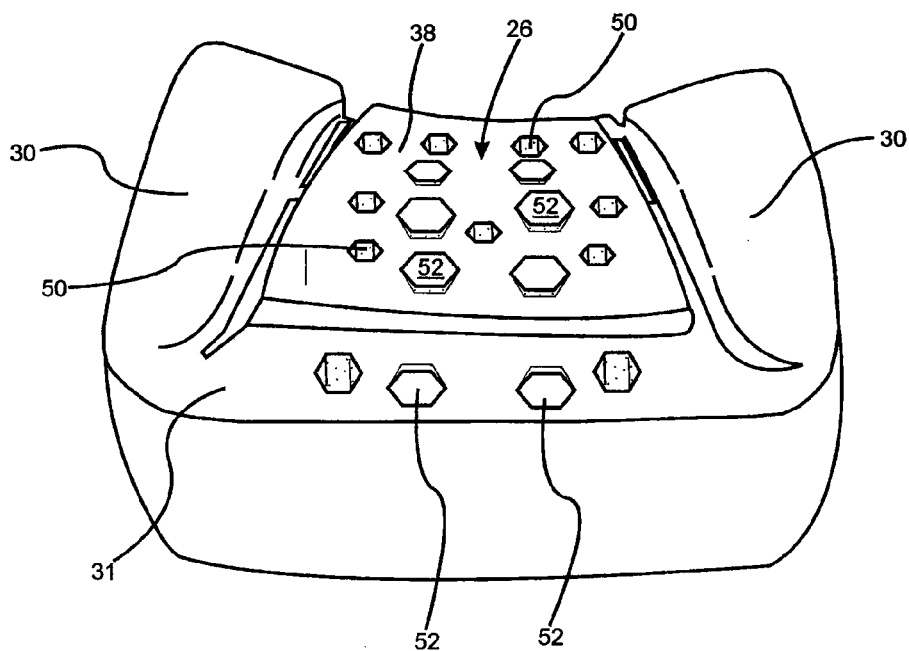


Figure 7

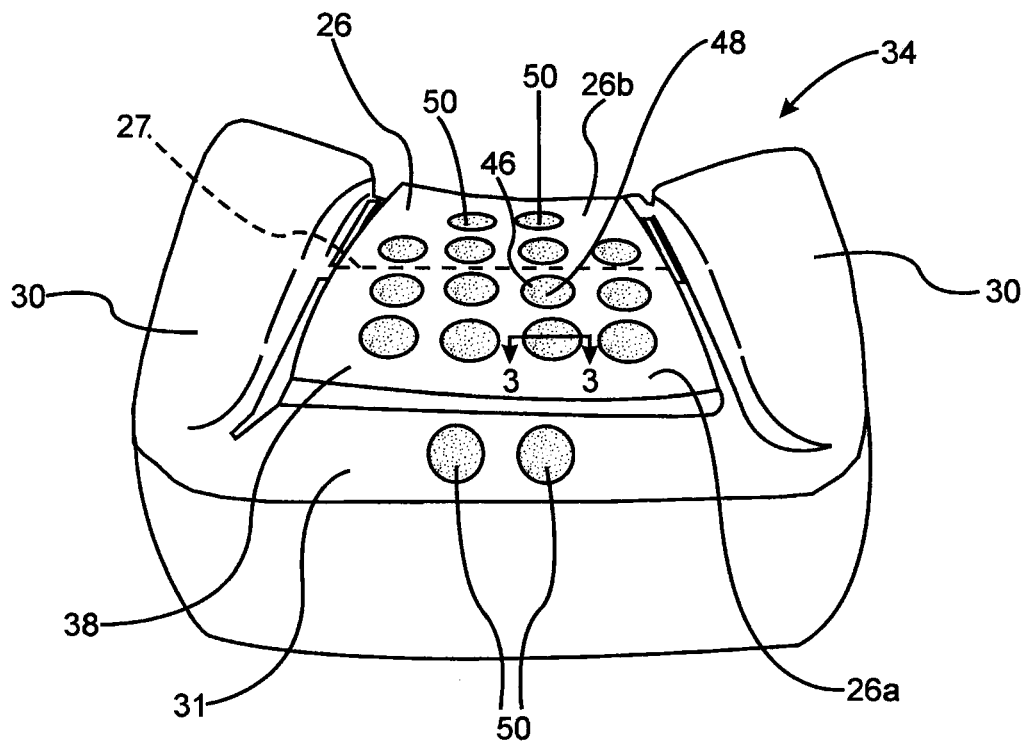


Figure 2

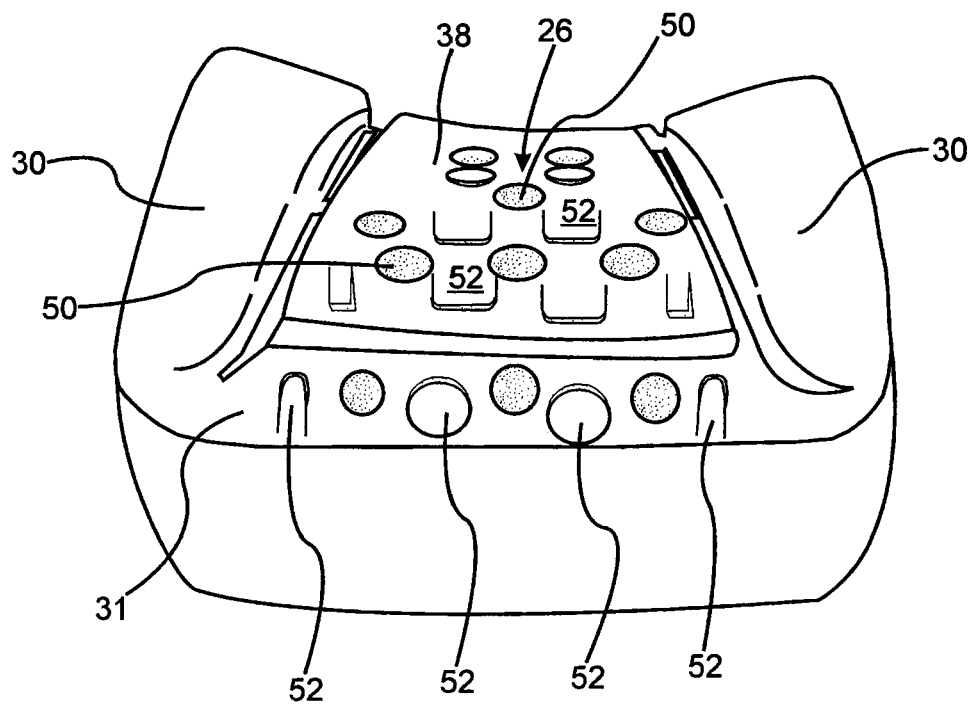


Figure 4

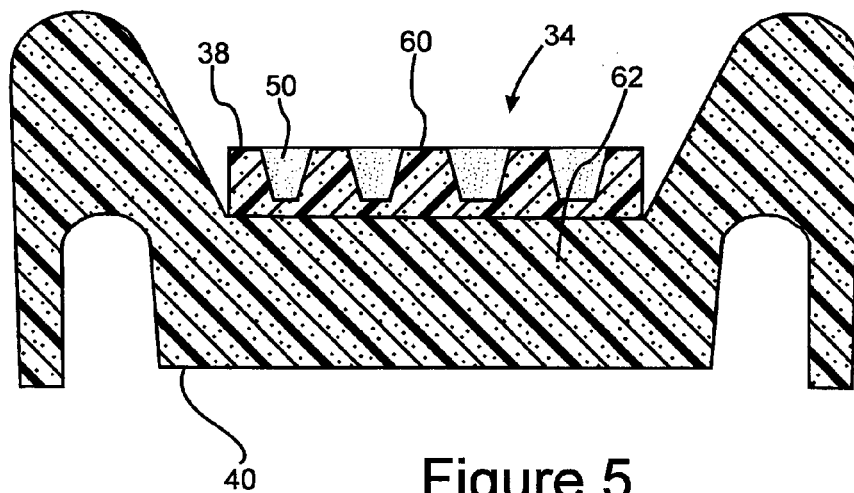


Figure 5

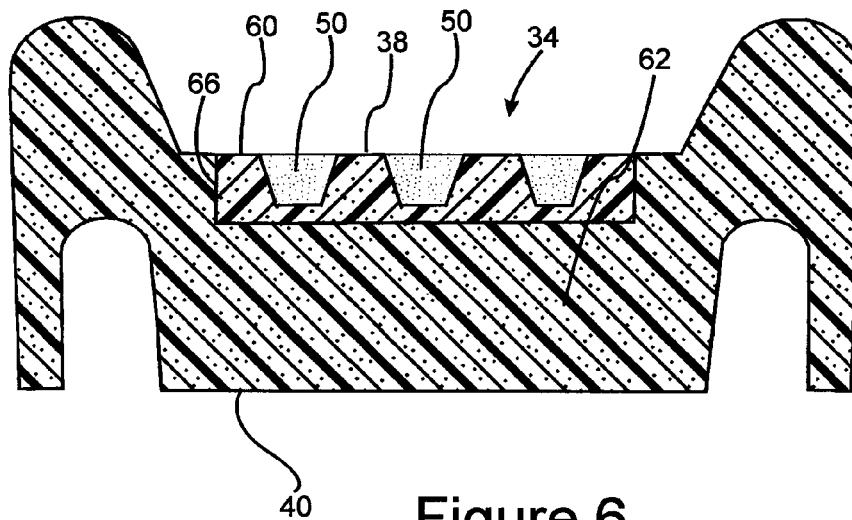


Figure 6

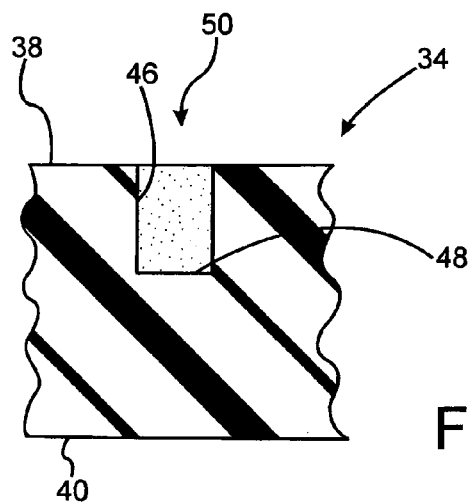


Figure 3

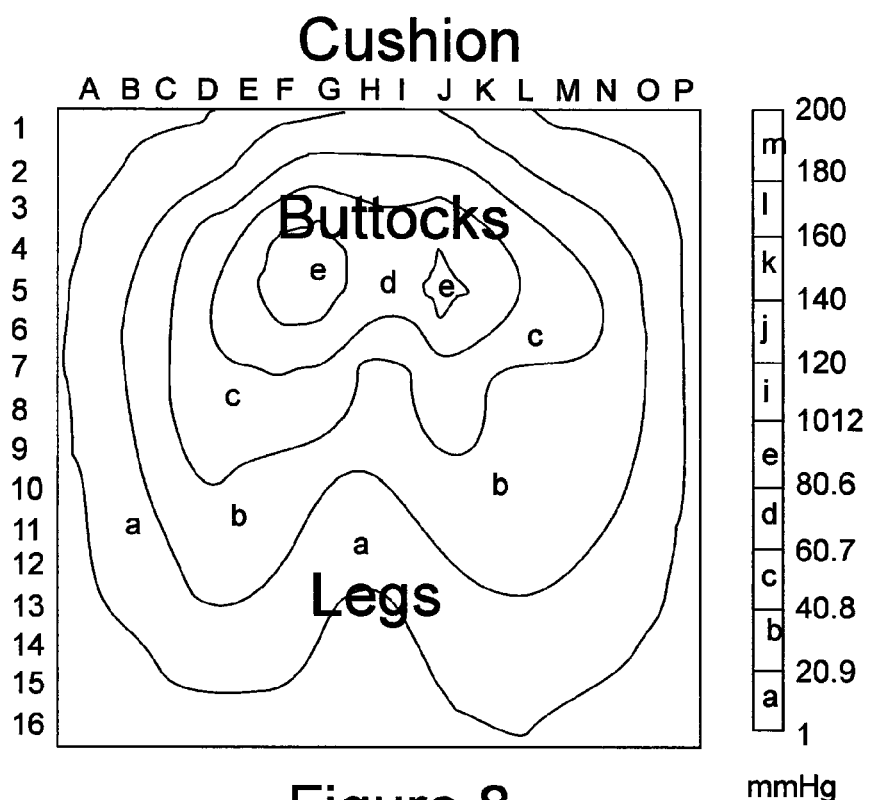


Figure 8

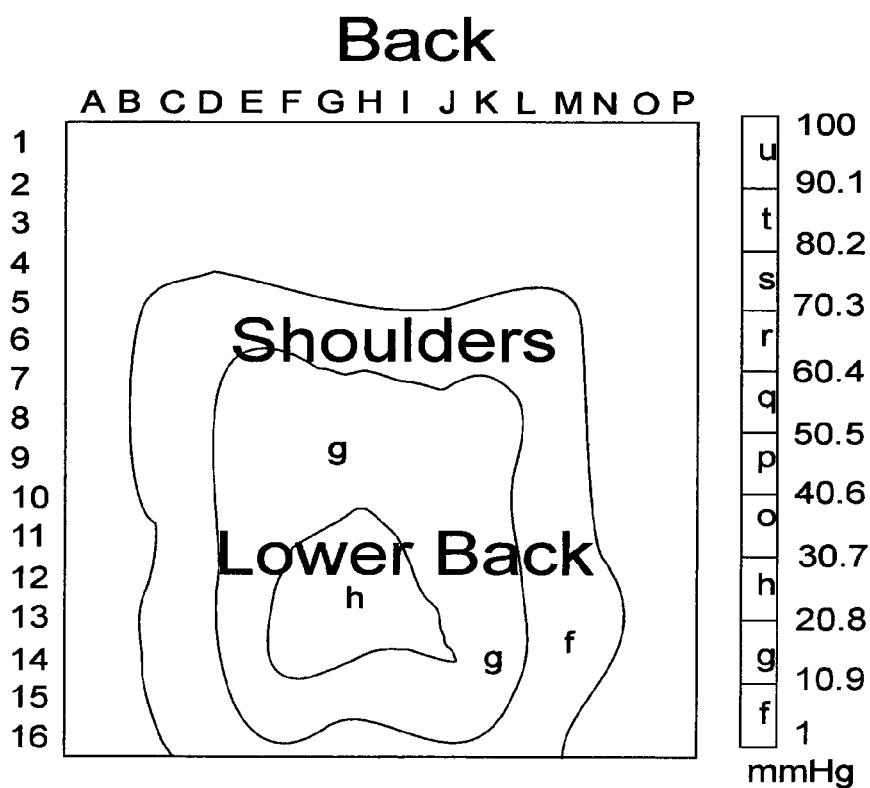


Figure 9

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VEHICLE SEAT ASSEMBLY HAVING A HARDNESS GRADIENT VIA "A" SURFACE INTRUSIONS AND/OR PROTRUSIONS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 12/685,797, filed Jan. 12, 2010, which is a divisional of U.S. application Ser. No. 11/468,469 filed Aug. 30, 2006, which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a vehicle seat assembly having a hardness gradient and method of making the same. More specifically, the present invention relates to a vehicle seat assembly having areas that are configured to be less hard than other areas of the seat assembly and methods of making the same.

2. Background Art

Generally speaking, a vehicle seat assembly includes three fundamental components: (a) a frame to support the seat assembly and to mount it to a vehicle; (b) a foam cushion to cover the frame; and (c) trim material to cover the foam cushion and provide a durable surface for contact with a vehicle occupant. Typically, the foam cushion is made from an expandable foam material, such as polyurethane, and is molded to a predetermined shape during a molded process. For example, the predetermined shape of a typical bucket-style seat includes raised front, side, and rear bolster areas and recessed central seating and back sections. The trim material may include any number of materials, such as cloth, polymers, or leather. Often, the selection of trim material is governed by the sale price of the vehicle. For example, leather trim material may be used for luxury vehicles while cloth and polymeric materials may be used for less expensive vehicles.

An important consideration in the manufacture of seat cushions is to provide inboard and outboard portions of the seat cushion which are relatively resistant to premature wear while providing an insert or center portion which is soft and comfortable. Inboard and outboard sides of the vehicle seat assembly typically bear most of the load when the occupant gets in and out of the vehicle and therefore require additional rigidity relative to the center insert portion of the vehicle seat assembly. Presently, there is no relatively inexpensive and simple way of providing a vehicle seat assembly having more rigid inboard and/or outboard bolster areas relative to the center insert area.

Accordingly, there is a need to provide a vehicle seat assembly which has a seat cushion that has a relatively rigid outboard and inboard bolster area and a relatively less rigid center portion area which can be manufactured easily and relatively economically.

SUMMARY OF THE INVENTION

According to at least one aspect of the present invention, a vehicle seat assembly is provided. In at least one embodiment, the vehicle seat assembly comprises a cushion having an "A" surface and a "B" surface, a central portion, and two bolster areas, with each bolster area being adjacent the central portion. In at least this embodiment, the cushion has a plurality of intrusions extending from the "A" surface towards the "B" surface to form a hardness gradient between at least one of the bolster areas and the central portion of between 8% to

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25%. Cushions having a hardness gradient of 8% to 25% between the central portion and at least one bolster area will have a desirable comfort, durability, vibration resistance, and safety performance.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cut-away environmental view of a vehicle seat assembly in accordance with an embodiment of the present invention;

FIG. 2 is a top perspective view of a bottom seat cushion useable with the vehicle seat assembly illustrated in FIG. 1;

FIG. 3 is a cross-sectional view of the seat cushion illustrated in FIG. 2;

FIG. 4 is a view similar to FIG. 2 showing another embodiment of the present invention;

FIG. 5 is a cross sectional view illustrating another embodiment of a bottom seat cushion useable with the seat assembly of the present invention;

FIG. 6 is a view similar to FIG. 5 showing another embodiment of the present invention;

FIG. 7 is a view similar to FIG. 5 showing yet another embodiment of the present invention;

FIG. 8 illustrates an example of occupant pressure modeling for a seat bottom cushion; and

FIG. 9 illustrates an example of occupant pressure modeling for a seat back cushion.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

As required, detailed embodiments of the present invention are disclosed herein. However, it is to be understood that the disclosed embodiments are merely exemplary of the invention that may be embodied in various and alternative forms. The figures are not necessarily to scale, some features may be exaggerated or minimized to show details of particular components. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a representative basis for the claims and/or as a representative basis for teaching one skilled in the art to variously employ the present invention.

Moreover, except where otherwise expressly indicated, all numerical quantities in this description and in the claims are to be understood as modified by the word "about" in describing the broader scope of this invention. Practice within the numerical limits stated is generally preferred. Also, unless expressly stated to the contrary, the description of a group or class of materials by suitable or preferred for a given purpose in connection with the invention implies that mixtures of any two or more members of the group or class may be equally suitable or preferred.

Referring now to the figures, where like numerals are used to designate like structure throughout to the drawings, a schematic vehicle seat assembly in accordance with at least one embodiment of the present invention is generally shown at 10 in FIG. 1. While the vehicle seat assembly 10 is illustrated in FIG. 1 to be a bucket seat assembly, it should be understood that the principles of the present invention are applicable to other types of seat assemblies, such as bench, captain, and other types of seat assemblies. It should also be understood that the principles of the present invention are applicable to other applications where foam is a component such as back rests, back support pads, arm rests, and head restraints.

As shown in FIG. 1, the vehicle seat assembly 10 includes a seat frame, generally indicated at 14 having a plurality of mounting brackets (not shown) adapted to operatively secure

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the seat frame within a vehicle. The seat frame **14** may be constructed from any material suitable for application within a vehicle seat assembly **10**, such as aluminum, steel or other metal alloy or a suitable polymer. Further, the seat frame **14** may be manufactured using a technique commonly known in the art, relative to the type of material employed. By way of example, manufacturing techniques may include stamping, welding, fastening or molding a suitable material to form a seat frame **14**.

The vehicle seat assembly **10** comprises a seat back, generally indicated at **16**, and a lower seat assembly, generally indicated at **18**. In at least the illustrated embodiment, the seat back **16** includes a central back support pad **20**, side bolsters **22**, and trenches **24** between the bolsters **22** and the pad **20**. In at least the illustrated embodiment, the lower seat assembly **18** includes a central seating pad **26**, a plurality of bolsters **30** and **31** substantially surrounding at least two opposing sides, and as shown here, three sides, of the central seating pad **26**, and trenches **32** between the bolsters **30** and **31** and the pad **26**. Bolsters **30** are located at opposite sides (i.e., inboard and outboard) of the lower seat assembly **12** and the bolster **31** is located at the front of the lower seat assembly **18** and extends between and connects the front portions of the bolsters **30**.

The vehicle seat assembly **12** further includes a back foam cushion (not shown) and a seat foam cushion generally indicated at **34**. The seat foam cushion **34** is conventionally secured to the seat frame **14** and/or a seat assembly infrastructure (not shown). The foam cushion **34** may be secured to the seat frame **14** and/or infrastructure by any method generally known in the art, such as by an adhesive. It should be understood while the foam cushion **34** is illustrated to be a bucket-seat bottom cushion, the present invention can be applicable to any type of seat cushion such as a seat back cushion for a bucket-seat and seat back and bottom cushion for bench seats, as well as other types of seats.

The vehicle seat assembly **12** also includes a trim material **36** adapted to engage the foam cushion **34** (or cushions) in a covering relationship. The trim material **36** may include any material commonly known in the art. By way of example, some of the known materials include cloth, leather, or polymers of sufficient quality and thickness for use in seat trim applications. Polymer trim materials may include a flexible closed cell polymer skin material such as polyvinyl, polyvinyl chloride (PVC), thermoplastic olefin (TPO), or thermoplastic urethane (TPU). Additionally, materials for use as trim material **36** may include a foam backing (not shown, but generally known in the art) which may be manufactured from a variety of polymer foam materials. By way of example, the foam backing may be polyethylene, polypropylene, polyurethane, or a polystyrene foam. Optionally, a mesh or reinforcing material (not shown, but generally known in the art) such as fiberglass or nylon may be applied to the foam backing or back of the trim material **36** for increasing strength without increasing rigidity.

The seat cushion **34** has an upper surface **38** and a lower surface **40** that is spaced from the upper surface **38**. The upper surface **38** of the seat cushion **34** may be referred to as the "A" surface, and the lower surface **40** may be referred to as the "B" surface. The seat cushion **34** also defines an inboard side **42** and an outboard side **44**. When an occupant (not shown) is supported on the lower seat assembly **18**, the weight of the occupant will generally apply an axial load directed generally through the upper surface **38** of the seat cushion **34** towards the lower surface **40**. Although the weight of the occupant will generally induce an axial as well as sheer force in the seat cushion **34**, those having ordinary skill in the art will recognize that the primary load path of the occupant's weight will

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be substantially vertical from the upper surface **38** towards the lower surface **40** through the seat cushion. However, when the occupant is getting in and out of the vehicle, an increased and substantially sizeable load will typically be placed on the inboard and outboard bolster portions **30** of the seat cushion **34**.

In accordance with the present invention, a seat cushion **34** is provided that has bolster portions **30** having a greater hardness relative to the central seating pad **26**. In at least one embodiment, the bolster **31** also has a greater hardness relative to the central seating pad **26**. To provide the desired hardness gradient, seat cushion **34** can be provided with intrusions extending from the "A" surface **38** towards the "B" surface **40** in one or more of the bolster areas **30** and/or **31** and/or the center area **26** to provide a seat cushion **34** having varying hardness areas. In at least another embodiment, the seat cushion **34** can further be provided with protrusions extending from the "A" and/or the "B" surfaces **38** and **40** away from the other surface in the bolster areas **30** and/or **31** and/or the center area **26** to provide a seat cushion **34** having varying hardness areas. For instance, the seat cushion **34** is configured so that one or more (or all) of the bolsters **30** is harder than the central seating pad **26**.

In at least one embodiment, the present invention enables the modification of the hardness of the foam primarily in the central seating pad **26**, i.e., areas of typical consumer contact while driving, while keeping the other areas of the seat cushion **34**, i.e., the bolsters **30** and **31**, firmer to enable improved craftsmanship and durability performance and provide lateral support to occupants while traveling on curved roadways and during turning. Such a configuration enables the central seating pad **26** to be softer for improved occupant comfort while allowing the bolster(s) **30** and/or **31** to be harder to account for the typically higher loads placed upon the bolster(s) **30** and/or **31** upon occupant ingress and egress. Such a configuration can also assist the seat assembly **10** in achieving H-point specification without significantly modifying seat assembly packaging. In other words, the implementation of intrusions and/or protrusions in accordance with the present invention can modify the seat cushion **34** in such a way that allows the seat assembly **10** to achieve a desired H-point without having to change the overall shape or size of the cushion **34**. Additionally, the implementation of intrusions (and in some instances the protrusions) can also assist the seat assembly **10** in achieving a weight reduction and/or cost reduction.

While the harness gradient can generally be achieved by providing intrusions such as holes and/or other geometric openings that extend from the "A" surface **38** towards the "B" surface **40**, and/or protrusions on the surfaces **38** and/or **40** of the seat cushion **34**, it is contemplated that the location, size, and/or shape of the intrusions and/or protrusions can vary as desired. However, in at least one embodiment, the seat cushion **34** of the present invention has a hardness gradient between at least one of the bolsters **30** and **31** and the central seating pad **26** area of the seat cushion **34** of between 8% to 25%. In other words, at least one of the bolster areas **30** and **31** has a hardness that is at least 8% to 25% greater than the hardness of the central seating pad **26**. In at least certain embodiments, the seat cushion **34** has a hardness gradient between the bolsters **30** and the central seating pad **26** of between 8% to 25%. The hardness can be measured by indentation force deflection (IFD) as measured by ASTM test method No. D3574. In another embodiment, the seat cushion **34** of the present invention has a hardness gradient between at least one of the bolsters **30** and **31** and the central seating pad

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26 of the seat cushion 34 of between 10% and 20%, and in other embodiments of between 12% and 18%.

In at least one embodiment, the hardness of the central seating pad 26 of the seat cushion 34, as measured by ASTM test method No. D3574, is between 100 and 300 newtons, and in other embodiments between 150 and 250 newtons. In at least another embodiment, the hardness of at least one of the bolsters 30 and 31, as measured by ASTM test method D3574, is between 230 and 350 newtons, and in other embodiments between 250 to 300 newtons. In at least certain embodiments, the hardness of each of the bolsters 30 and 31, as measured by ASTM test method D3574, is between 230 and 350 newtons and in other embodiments between 250 and 300 newtons.

Furthermore, in at least one embodiment, the seat cushion 34 of the present invention has a hysteresis loss gradient between at least one of the bolsters 30 and 31 and the central seating pad 26 area of the seat cushion 34 are between 8% to 25%. In other words, at least one bolster area has a hysteresis loss that is at least 8% to 25% less than the hysteresis loss of the central seating pad 26. The hysteresis loss can be measured by indentation force deflection (IFD) as measured by ASTM test method No. D3574. In another embodiment, the seat cushion 34 of the present invention has a hysteresis loss gradient between at least one of the bolsters 30 and the central seating pad 26 of the seat cushion 34 of between 10% and 20%, and in other embodiments of between 12% and 18%.

In at least one embodiment, the front bolster 31 has a lower hardness gradient relative to the central seating pad 26 than one or both of the side bolsters 30 to provide a front bolster 31 that is softer (primarily for comfort) than at least one of the side bolsters 30. In this embodiment, the front bolster has a hardness of 150 to 300 newtons, and in other embodiments of 200 to 250 newtons. In this embodiment, the hardness gradient between the front bolster 31 and at least one of the central seating pad 26 is 5% to 20%, and the hardness gradient between the front bolster 31 and the side bolsters 30 is 8% to 25%. In at least one other embodiment, the hardness gradient between the front bolster 31 and the central seating pad 26 is 8% to 18%, and the hardness gradient between at least one of the front bolster 31 and the side bolsters 30 is 10% to 22%.

Referring to FIGS. 2 and 3, schematic perspective and cross-sectional views of an embodiment of a seat cushion 34 is shown. In this embodiment, the central seating pad 26 has a number of openings or holes 50 that extend from the "A" surface 38 towards the "B" surface 40. In at least one embodiment, the holes 50 include a generally axial, generally cylindrical wall 46 that extends between and connects the "A" surface 38 with a generally transverse hole bottom surface 48. In at least one embodiment, hole bottom surface 48 is spaced 0.1 to 5 cm from the "A" surface 38, in at least another embodiment 0.5 to 3.25 cm, and in yet another embodiment 1 to 2.5 cm.

While the openings 50 are shown to be circular, it should be understood that the openings 50 can vary in size and shape as desired. For instance, while the openings 50 are shown to be cylindrical holes, it should be understood that they could be channels and/or slots, and/or frustoconical, conical, polygonal or other geometric cutouts, such as rectangles, squares, triangles, honeycombs (as will be disclosed below), etc.

While the location, size and/or shape of the openings 50 and projections 52 can vary as desired, in at least one embodiment, the location, size and/or shape of the openings and/or projections can be selected based upon a counter response to pressure input of an average measurement of demographic matching consumers in static and dynamic measured clinics in the vehicle. FIGS. 8 and 9 illustrate examples of average

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pressure modeling of demographic matching consumers for a seat cushion and a seat back, respectively. In FIG. 8, area a displays a pressure range of 1 to 20.9 mm Hg of pressure, area b displays a pressure range of 30 to 40.88 mm Hg of pressure, area c displays a pressure range of 40.9 to 60.8 mm Hg of pressure, area d displays a pressure range of 60.9 to 80.6 mm Hg of pressure, and area e displays a pressure range of 80.7 to 101 mm Hg of pressure. In FIG. 9, area f displays a pressure range of 1 to 10.9 mm Hg of pressure, area g displays a pressure range of 11 to 20.8 mm Hg of pressure, and area h displays a pressure range of 20.9 to 30.7 mm Hg of pressure.

In at least one embodiment, the cushion 34 can be tuned with openings 50 and/or projections 52 to provide areas of lower hardness in areas of expected higher occupant pressure. Thus, in at least one embodiment, the areas of expected higher occupant pressure will have less openings 50 and/or projections 52 and/or smaller openings than areas of expected lower occupant pressure.

FIGS. 2, 4 and 7 illustrate a few examples of different openings 50 and/or projections 52 configurations. In at least the embodiment illustrated in FIG. 2, there are 16 openings 50 in the "A" surface 38 of the cushion 34. However, it should be understood the number, size, shape, and/or location of openings 50 can vary as desired. In at least the embodiment illustrated in FIG. 2, the front bolster 31 has two openings 50 whereas the side bolsters 30 have none. This enables the front bolster 31 to have a lower hardness gradient relative to the central seating pad 26 than the side bolsters 30. While the front bolster 31 is illustrated in FIG. 2 as having two openings 50, it should be understood that the front bolsters could have less or more openings as desired.

In at least the embodiment illustrated in FIG. 2, the central seating pad 26 is divided into two halves, a front half 26a and a rear half 26b, as schematically shown by imaginary dashed line 27. In at least this embodiment, the rear half 26b has a lower hardness gradient relative to the side bolsters 30 than the front half 26a to provide a front half 26a that is softer (primarily for comfort) than the rear half 26b. In at least this embodiment, the front half 26a of the central seating pad 26 could have a hardness of 150 to 250 newtons and the rear half 26b could have a hardness of 200 to 350 newtons. In at least this embodiment, the front half 26a of the central seating pad 26 could have a hardness gradient relative to the side bolster 30 of 8 to 15% and the rear half 26b could have a hardness gradient relative to the side bolster 30 of 12 to 25%.

While the front half 26a and the rear half 26b are illustrated in FIG. 2 as having eight and six openings 50, respectively, it should be understood that the number of openings 50 in each half 26a and 26b could vary as desired. While it should be understood that the size and shape of the openings 50 can vary as desired, in at least one embodiment, the openings 50 have a diameter of 0.2 to 5 cm., in other embodiments of 0.5 to 3.25 cm., and in yet other embodiments of 1 to 2.5 cm. Furthermore, in at least one embodiment, the openings 50 have a depth or length of 0.1 to 5 cm., in other embodiments of 0.25 to 2.5 cm., and in yet other embodiments of 0.5 to 2 cm. Moreover, in at least one embodiment, it has been found useful to provide the openings 50 with a radius of 4 to 15 mm, and in other embodiments of 6 to 12 mm, to assist in the molding of the seat cushion.

FIG. 4 illustrates another embodiment of the seat cushion 34. In this embodiment, protrusions 52 can be provided on the "A" surface 38 and/or "B" surface 40 of the seat pad 26. The protrusions 52 extend away from the "A" surface and/or the "B" surface 40. Like the openings 50, the protrusions 52 can vary in size, shape, location, and/or number as desired. The protrusions 52 help to provide desirable force resistance

properties for the pad **26** in response to comfort, vibration and/or shock inputs. For instance, the protrusions **52** can provide reinforcement at localized points of contact and/or provide lower or higher hardness areas relative to their surrounding regions.

In at least one embodiment, the protrusions **52** have a length of 0.2 to 5 cm., in other embodiments of 0.5 to 3.25 cm., and in yet another embodiment of 1 to 2.5 cm. In at least one embodiment, the protrusions **52** have a width of 0.5 to 5 cm., in other embodiments of 0.5 to 3.25 cm., and in yet another embodiment of 1 to 2.5 cm. In at least one embodiment, the protrusions **52** have a height of 0.1 to 5 cm, in other embodiments of 0.25 to 2.5 cm., and in yet other embodiments of 0.5 to 2 cm. Moreover, in at least another embodiment, each of the protrusions **52** have a depth or length that is 5% to 50% of the total depth or thickness of the cushion **34** in the area of the respective protrusion, in other embodiments of 10% to 40% of the total depth or thickness of the cushion in the area of the respective protrusion, and in yet other embodiments of 15% to 35% of the total depth or thickness of the cushion in the area of the respective protrusion. It should be understood that the size, shape, and/or geometry of the openings **50** and/or protrusions **52** can vary from each other. For instance, one opening can be different in size, shape, and/or geometry from another opening **50** and/or protrusion **52**.

Moreover, while the openings **50** can be provided to provide a density and/or hardness gradient to tailor the specific comfort requirements of the seat assembly, the openings **50** could also be used to reduce weight of the overall seat assembly, and in particular the foam cushion **34**. For instance, the foam could be cored to have intrusions such as holes and/or channels in areas of large seating surfaces such as armrests and/or center portions between seat occupants. Furthermore, as discussed above, the openings **50** can be provided to assist the seat assembly **10** in achieving a desired H-point and/or cost reduction. Moreover, while the seat assembly **10** has been described as having bolster portion(s) that are harder than the remainder of the seat assembly, it should be understood that the principles of the present invention can be used to manufacture seat assemblies having areas of the seat assemblies that are harder, or at least as hard, as one or more of the bolsters.

The seat cushion **34** of the present invention can be made by a variety of methods. In at least one embodiment, the seat cushion **34** is made by molding wherein the intrusions and/or protrusions are molded into the seat cushion **34** during the molding operation. In this embodiment, the foam molding tool can be provided with protrusions and/or cavities around and/or within which the foam can be molded. In at least one embodiment, it has been found useful to provide molding tools having molding surfaces that result in openings **50** and/or protrusions **52** having a radius of 4 to 15 mm, and in other embodiments of 6 to 12 mm, to assist in the molding of the seat cushion.

Referring to FIG. **5**, in at least another embodiment, intrusions (openings) **50** and/or protrusions **52** are molded into a foam sub-assembly **60** which is then secured to a seat bottom **62** not having protrusions and/or opening (at least a substantial amount which would cause the necessary density gradient). It should be understood that other manufacturing means could be used, such as die-cutting the openings **50**. In at least one embodiment, the seat bottom **62** has the “B” surface **40** and the subassembly **60** has the “A” surface **38**, however, it should be understood that this configuration could be reversed. Referring to FIG. **6**, the seat bottom **62** has a cavity **66** within which sub-assembly **60** is received. In these

embodiments, the subassembly **60** can be secured to the seat bottom **62** by any suitable method such as adhesion and/or fasteners.

FIG. **7** illustrates an embodiment where the openings **50** and protrusions **52** are honey-combed in shape. The honey-comb shape can provide an increased structural integrity relative to other shapes. For instance, the hexahedral wall structure can provide a relatively high force resistance efficiency. While the openings **50** and the protrusions **52** are shown to be the same shape in FIG. **7**, it should be understood that the openings **50** could be shaped differently than the protrusions **52**.

While embodiments of the invention have been illustrated and described, it is not intended that these embodiments illustrate and describe all possible forms of the invention. Moreover, the words used in the specification are words of description rather than limitation, and it is understood that various changes may be made without departing from spirit and scope of the invention.

What is claimed is:

1. A vehicle seat assembly comprising:

a cushion having an “A” surface and a “B” surface, a seating portion, and at least one bolster area adjacent the seating portion, the cushion having a plurality of intrusions extending from one of the “A” surface or the “B” surface towards the other of the “A” surface or the “B” surface to form a hardness gradient between the at least one bolster area and the seating portion, each of the intrusions having a first dimension extending across the intrusion and a second corresponding dimension extending across the intrusion, the second dimension being spaced further from the one surface than the first dimension and being smaller than the first dimension, the seating portion having a front portion and a rear portion rearward of the front portion, with the front portion having a lower hardness than the rear portion; and a trim material secured to the seat assembly so a portion of the trim material is disposed over the “A” surface of the cushion.

2. The vehicle seat assembly of claim **1** wherein the at least one bolster areas has a hardness that is at least 8% greater than the hardness of the seating portion.

3. The vehicle seat assembly of claim **1** wherein the seating portion has holes formed in the “A” surface to provide a reduced hardness relative to the at least one bolster area.

4. The vehicle seat assembly of claim **3** wherein the holes have a diameter of 0.2 to 5.0 cm. and a length of 0.1 to 5 cm.

5. The vehicle seat assembly of claim **4** wherein the cushion comprises a molded foam cushion, with the holes being formed during the molding of the cushion.

6. The vehicle seat assembly of claim **3** wherein the plurality of intrusions are formed in the “A” surface.

7. The vehicle seat assembly of claim **6** wherein the intrusions extend from the “A” surface towards the “B” surface a distance of 0.1 to 5.0 cm.

8. The vehicle seat assembly of claim **1** wherein the hardness gradient between the at least one bolster area and the seating portion is 8% to 25%.

9. The vehicle seat assembly of claim **1** wherein the cushion comprises a bench seat bottom.

10. A vehicle seat assembly comprising:

a cushion having an “A” surface and a “B” surface, a seating portion, two side bolster areas adjacent the seating portion, wherein the seating portion of the cushion has a first plurality of intrusions extending from one of the “A” surface or the “B” surface towards the other of the “B” surface or the “A” surface to form a hardness

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gradient between at least one of the side bolster areas and the seating portion, the seating portion having a front portion and a rear portion rearward of the front portion, with the front portion having a lower hardness than the rear portion; and

a trim material disposed over the seat assembly so at least a portion of the trim material is over the “A” surface of the cushion.

11. The vehicle seat assembly of claim 10 wherein the at least one of the side bolster areas has a hardness that is at least 8% greater than the hardness of the seating portion.

12. The vehicle seat assembly of claim 10 wherein the seating portion has holes formed therein to provide a reduced hardness relative to the at least one bolster area.

13. The vehicle seat assembly of claim 12 wherein the holes have a diameter of 0.2 to 5.0 cm. and a length of 0.1 to 5 cm.

14. The vehicle seat assembly of claim 13 wherein the cushion comprises a molded foam cushion and the holes are formed during the molding of the cushion.

15. The vehicle seat assembly of claim 10 wherein the plurality of intrusions are formed in the seating portion.

16. The vehicle seat assembly of claim 10 wherein the cushion comprises a bench seat bottom.

17. A vehicle seat assembly comprising:

a cushion having an “A” surface, a “B” surface, at least one seating portion, and two side bolster areas adjacent the seating portion, wherein the seating portion of the cush-

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ion has intrusions extending from the “A” surface or the “B” surface towards the other of the “B” surface or the “A” surface to form a hardness gradient between at least one of the side bolster areas and the seating portion each of the intrusions having a first dimension extending across the intrusion and a second corresponding dimension extending across the intrusion, the second dimension being spaced further from the one surface than the first dimension and being smaller than the first dimension, the seating portion having a front portion and a rear portion rearward of the front portion, with the front portion having a lower hardness than the rear portion; and

a trim material disposed over the seat assembly so at least a portion of the trim material is over the “A” surface of the cushion.

18. The vehicle seat assembly of claim 17 wherein the at least one bolster areas has a hardness that is at least 8% greater than the hardness of the seating portion, and wherein the seating portion has holes formed therein to provide a reduced hardness relative to the at least one bolster area.

19. The vehicle seat assembly of claim 17 wherein the hardness gradient between the at least one bolster area and the seating portion is 8% to 25%.

20. The vehicle seat assembly of claim 17 wherein the cushion comprises a bench seat cushion.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 9,421,895 B2
APPLICATION NO. : 14/705743
DATED : August 23, 2016
INVENTOR(S) : Asad S. Ali et al.

Page 1 of 1

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

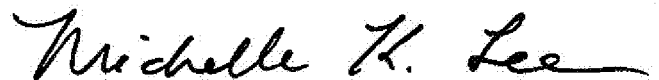
In the Claims

Column 10, Line 18, Claim 18:

Delete “areas” and

Insert -- area --.

Signed and Sealed this
Twenty-fourth Day of January, 2017

A handwritten signature in black ink, reading "Michelle K. Lee". The signature is fluid and cursive, with the first letters of each name being capitalized and prominent.

Michelle K. Lee
Director of the United States Patent and Trademark Office